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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 4254

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Submitted for recognition as an American National Standard

LAMINATED SHEET, ALUMINUM ALLOY, ARAMID-FIBER-REINFORCED
4.4Cu - 1.5Mg - 0.6Mn (2024-T3)
3, 5, 7, or 9 Ply

1. SCOPE:

1.1 Form: This specification covers aluminum alloy sheet laminated with one or more layers of unidirectional aramid fiber/epoxy prepreg. The outer layers are always aluminum alloy and, when specified, one or both shall be one side alclad with the cladding on the exposed or outside surface.

1.2 Application: Primarily for structural parts requiring strength, fatigue-crack-growth resistance, and damage tolerance properties.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2202 - Tolerances, Aluminum Alloy and Magnesium Alloy Sheet and Plate
MAM 2202 - Tolerances, Metric, Aluminum Alloy and Magnesium Alloy Sheet and Plate
AMS 2350 - Standards and Test Methods
AMS 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys (Except Forging Stock) and Flash Welded Rings
MAM 2355 - Quality Assurance Sampling and Testing of Aluminum Alloys and Magnesium Alloys (Except Forging Stock) and Flash Welded Rings, Metric (SI) Units
AMS 2468 - Hard Coating Treatment of Aluminum Alloys
AMS 2470 - Anodic Treatment of Aluminum Alloys, Chromic Acid Process
AMS 4036 - Aluminum Alloy Sheet and Plate, Alclad One Side, 4.4Cu - 1.5Mg - 0.60Mn, (Alclad One Side 2024 and 1-1/2% Alclad One Side 2024-T3 Sheet); 1-1/2% Alclad One Side 2024-T351 Plate)
AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn (2024; -T3 Flat Sheet, -T351 Plate), Solution Heat Treated

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM B660 - Packaging/Packing of Aluminum and Magnesium Products
ASTM E338 - Sharp-Notch Tension Testing of High-Strength Sheet Materials
ASTM D3167 - Floating Roller Peel Resistance of Adhesives

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Specifications:

MMM-A-132 - Adhesive, Heat Resistant, Airframe Structural, Metal to Metal

3. TECHNICAL REQUIREMENTS:

3.1 Material:

3.1.1 The aluminum alloy sheet layers shall be 0.012 inch (0.30 mm) thick AMS 4037 sheet. When specified by purchaser, one or both outside plies of the laminate shall be alclad one side AMS 4036 aluminum sheet with the cladding being the exposed surface.

3.1.2 Interior layers of the laminate shall consist of one or more layers of unidirectional aramid fibers preimpregnated with epoxy resin adhesive, hereafter referred to as prepreg. If more than one layer of prepreg is used they shall be separated by sheets of aluminum as described in 3.2.1.

3.1.3 The 3, 5, 7, and 9 ply sheets are 0.032, 0.053, 0.073, and 0.094 inches (0.81, 1.35, 1.85, and 2.39 mm), respectively, in nominal thickness.

3.2 Laminating:

3.2.1 Faying (bonding) surfaces of the aluminum sheets, before assembly as a laminate, shall be cleaned and rinsed, etched and rinsed, and anodized (but not sealed) according to AMS 2468, AMS 2470 or other process agreed upon by purchaser and vendor. All anodized surfaces shall be primed and then bonded in accordance with MMM-A-132, using Type I adhesive.

3.2.2 The epoxy adhesive in the prepreg shall conform to MMM-A-132. The aramid fiber and the quality characteristics of the prepreg shall be controlled by a specification mutually acceptable to purchaser and vendor. The prepreg shall be laid in the laminate assembly so that the fibers of all layers are oriented longitudinally, corresponding to the rolling direction of the aluminum sheets.

3.2.3 Assembly sequence or lay-up of the laminate components, with aluminum sheet represented by A and prepreg represented by p, is as follows:

Thickness		Laminate	Lay-Up
Inch	Millimetres	Type	Sequence
0.032	0.81	Type 2/1	A/p/A
0.053	1.35	Type 3/2	A/p/A/p/A
0.073	1.85	Type 4/3	A/p/A/p/A/p/A
0.094	2.39	Type 5/4	A/p/A/p/A/p/A/p/A

3.2.4 After lay-up, laminates shall be cured (bonded) using heat and pressure by a process, such as autoclaving, to produce the required properties. A typical practice is 1 hour at 260°F ± 10 (127°C ± 6) at a pressure of 70 - 75 psi (483 - 517 kPa).

3.2.5 When specified, the laminate shall be processed to adjust residual stresses (ARS) by causing the aluminum components to be in longitudinal compression rather than in tension. Adjusting residual stresses, as by stretching after curing to achieve 0.35 to 0.5% permanent set, slightly increases the tensile ultimate and the tensile yield strengths and enhances resistance to fatigue crack growth.

3.2.6 When specified, exterior surfaces of laminates shall be supplied anodized and primed.

3.3 Properties: Laminated sheet shall conform to the following requirements, determined in accordance with AMS 2355 or MAM 2355 except as specified in 3.3.2 and 3.3.3.

3.3.1 Tensile Properties: Shall be as specified in Table I, determined using a specimen with 3 inch (76 mm) fillet radius instead of the 0.500 inch (12.70 mm).

TABLE I

Nominal Thickness Inch	Specimen Orientation	Tensile Strength psi, min	Yield Strength at 0.2% Offset psi, minimum
0.032	Longitudinal	87,000	47,000
	Long-Transverse	47,000	32,000
0.053	Longitudinal	93,000	47,000
	Long-Transverse	44,000	31,000
0.073	Longitudinal	93,000	48,000
	Long-Transverse	41,000	30,000
0.094	Longitudinal	93,000	48,000
	Long-Transverse	39,000	29,000

TABLE I (SI)

Nominal Thickness Millimetres	Specimen Orientation	Tensile Strength MPa, min	Yield Strength at 0.2% Offset MPa, minimum
0.81	Longitudinal	600	324
	Long-Transverse	324	221
1.35	Longitudinal	641	324
	Long-Transverse	303	214
1.85	Longitudinal	641	331
	Long-Transverse	283	207
2.39	Longitudinal	641	331
	Long-Transverse	269	200

3.3.2 Notch Tensile Strength: Shall be determined in accordance with ASTM E338 using a center-cracked 3 inches (76 mm) wide specimen. Acceptance standards shall be as agreed upon by purchaser and vendor.

3.3.3 Roller Peel Strength: Adhesion of either outer layer shall be determined in accordance with ASTM D3167. Acceptance standards shall be as agreed upon by purchaser and vendor.

3.4 Quality: Laminated sheet, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and imperfections detrimental to usage of the sheet.

3.4.1 Internal Soundness: Each laminated panel shall be inspected for anomalies and continuity of bond using either transmission or immersion ultrasonic techniques compatible with ASTM standards. Ultrasonic transducers shall operate with a minimum frequency of 5 megahertz regardless of the inspection method employed. Imperfections that produce, in a single pass through the material, a 50% or greater attenuation of ultrasound at 5 megahertz frequency over an area not to exceed 0.25 inch (6.4 mm) in diameter are cause for rejection.

3.5 Tolerances: Laminated sheet shall conform to all applicable requirements of AMS 2202 or MAM 2202 except as specified in 3.5.1.

3.5.1 Thickness tolerances shall be as follows:

Type 2/1	± 0.0025 inch (0.064 mm)
Types 3/2 and 4/3	± 0.003 inch (0.08 mm)
Type 5/4	± 0.0035 inch (0.089 mm)

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of laminated sheet shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the sheet conforms to the requirements of this specification.

4.2 Classification of Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

4.3 Sampling: Shall be in accordance with AMS 2355 or MAM 2355, and the following:

4.3.1 Inspection Lot: An identifiable quantity of laminated sheet of the same type (thickness) containing bare aluminum sheet from one heat treat lot, alclad one side aluminum sheet, if any, from one heat treat lot; prepreg from one manufacturer's-batch lot, cured in the same lamination cycle, and presented for vendor's inspection at one time.

4.3.2 Tensile Properties: One sample in full thickness from each 1000 pounds (454 kg) or part thereof from each inspection lot taken in both the longitudinal and the long-transverse directions.

4.3.3 Notch Tensile Test: One sample from each inspection lot taken in the longitudinal direction.

4.3.4 Roller Peel Test: One sample from each inspection lot taken in the long-transverse direction.